INVESTIGATIONS ON LIGHT AND HEAT, MADE AND PUBLISHED WHOLLY OR IN PART WITH APPROPRIATION FROM THE RUMFORD FUND.

XVIII.

A PHOTOGRAPHIC STUDY OF THE NEBULA OF ORION.

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Presented March 11, 1885.

No portion of the heavens has been more carefully studied than that containing the Nebula of Orion. The monographs by Prof. G. P. Bond (Annals Harvard College Observatory, V.) and by Prof. E. S. Holden (Washington Astronomical Observations for 1878, Appendix I.) show the vast amount of material collected by eye observations. For a photographic study of the same region the following specimens are in the photographic collection of the Harvard College Observatory: —

A. Artotype enlargement of the first photograph of the nebula taken by Dr. Henry Draper, September 30, 1880. Exposure, 51 minutes.

B. Artotype enlargement of a photograph taken by Dr. Henry Draper, March 11, 1881. Exposure, 106 minutes.

C. The original negative taken by Dr. Henry Draper on March 14, 1882. Exposure, 136 minutes. This negative, except for a slight photographic blemish, is nearly identical with that from which D. was taken.

D. An enlarged glass positive of the second photograph taken by Dr. Henry Draper, March 14, 1882. Exposure, 137 minutes. This positive is a duplicate of that employed in making the paper prints, E. The two positives were taken, and any objects resembling stars, but not found on both, were assumed to be defects, and were painted out of the other positive by Dr. Draper.

E. Several artotype enlargements of the second photograph, taken March 14, 1882, by Dr. Henry Draper.

F. Carbon print of photograph taken by Mr. Common with his 3-foot reflector, January 30, 1883. Exposure, 39 minutes. Enlargement about 7 times.

G. Glass positive, — a direct copy of the negative taken by Mr. Common with his 3-foot reflector, Februarv 26, 1883. Exposure, 60 minutes.

Admirable material is thus furnished for a comparison of the results of photographic and eye observations of this region. The photographs of the stars which are common to F and to the catalogue of Professor Bond (Annals, V. 270) were first compared by a method closely resembling that adopted by Argelander for the study of variable stars. Table I. gives the stars which were selected for standards, with which the others are to be compared. Each star in the photograph was then compared with two of these, — one a little brighter, the other a little fainter. The differences were estimated in grades. The sum of the two differences gave a measure of the interval between the two comparison stars. It frequently happened that no difference in brightness was perceptible between the star to be measured and one of the comparison stars. The number of measures of star intervals between the comparison stars is therefore less than the number of stars compared. In Table I. the successive columns give for each comparison star a designation, and the number and magnitude in the Bond catalogue. The next column gives the photographic magnitude, found by a process which will be detailed below. This is followed by the number of comparisons between each star and that following it, and the mean value of this difference in grades. The last column gives the assumed brightness in grades, and equals the number of grades by which each star is fainter than the first on the list.

TABLE I.

Desig.	Bond No.	Bond Magn.	Photog. Magn.	No. Comp.	Diff. Grades.	Grades.
a	570	9.4	9.4	1	1.0	0
b	505	11.3	9.5	3	3.0	1
c	523	10.1	9.8	2	2.5	4
d	479	10.0	10.1	5	2.4	7
e	449	10.5	10.4	8	3.0	9
f	427	10.7	10.9	8	3.0	12
g	506	11.3	11.3	5	2.0	15
h	458	11.2	11.6	7	4.2	17
i	373	12.0	12.3	3	3.0	21
j	409	13.9	13.0	9	2.9	24
k	378	14.8	13.8	6	3.0	27
l	490	14.2	14.8	5	2.8	30
m	737	15.0	15.6	....	....	33

The light of each star measured was next reduced to grades by the assumed light in grades of the comparison stars. Two values were found, — one derived from the brighter, the other from the fainter comparison star. In 50 cases the results agreed exactly, in 11 cases

they differed by one grade, and in one case only by two grades. The relation between the grades and the scale of magnitude of the Bond Catalogue was next found by grouping the stars by half-magnitudes. The middle points of each group are given in the first column of Table II., the number of stars in the group in the second column, and the mean of the corresponding values in grades in the third. Points were then constructed with the first and third columns as ordinates, and a smooth curve drawn through them. The comparative values of the

TABLE II.

Bond Magn.	No. Stars.	Gr.	Bond Magn.	No. Stars.	Gr.
9.5	2	0.5	13.0	7	22.7
10.0	10	6.1	13.5	4	27.5
10.5	11	9.4	14.0	14	27.2
11.0	11	11.9	14.5	....	....
11.5	12	16.8	15.0	9	30.6
12.0	3	18.7	16.5	1	37.0
12.5	9	24.8			

grades and magnitudes derived from this curve are given in Table III. Applying the results of this table to the last column of Table I. gives the fourth column of that table. The results for all the stars in the Bond Catalogue differing less than 1000″ in right ascension and declination from θ' *Orionis*, the brightest star in the nebula, are given

TABLE III.

Gr.	Magn.	Gr.	Magn.	Gr.	Magn.
0	9.4	12	10.9	24	13.0
1	9.5	13	11.0	25	13.2
2	9.6	14	11.2	26	13.5
3	9.7	15	11.3	27	13.8
4	9.8	16	11.5	28	14.1
5	9.9	17	11.6	29	14.5
6	10.0	18	11.8	30	14.8
7	10.1	19	12.0	31	15.1
8	10.3	20	12.1	32	15.3
9	10.4	21	12.3	33	15.6
10	10.6	22	12.5	34	15.8
11	10.7	23	12.7	35	16.1

in Table IV. The first four columns give the number, difference in right ascension and declination from θ' *Orionis*, and magnitude according to the Bond Catalogue. The fifth column gives the magnitude found as described above from F, the photograph of Mr. Common.

TABLE IV.

Bond No.	$\Delta\alpha$.	$\Delta\delta$.	Bond Magn.	Common Magn.	Draper Magn.	Resid. Common.	Resid. Draper.
303	—979.2	+ 13.9	9.9	10.0	....	+ 1	....
311	—928.2	+681.9	10.7	*a*	....	....	....
314	—923.1	—307.8	11.4	11.6	....	+ 2	....
315	—921.3	—825.4	10.2	10.3	....	+ 1	....
323	—886.4	—816.6	10.7	10.7	....	0	....
329	—867.6	—626.9	14.2	*d*	....	....	....
332	—863.9	—646.8	14.8	*d*	....	....	....
335	—851.6	—239.0	10.9	10.6	....	— 3	....
339	—839.7	—446.6	14.8	14.8	....	0	....
346	—833.4	—947 1	10.7	10.9	....	+ 2	....
347	—829.4	—462.6	14.8	*c*	....	....	....
363	—772.4	+ 66 3	10.7	10.3	....	— 4	....
370	—746.6	— 66.3	13.3	14.1	....	+ 8	....
373	—732.9	— 70.5	12.0	12.3	....	+ 3	....
377	—724.1	—525.0	11.3	11.5	....	+ 2	....
378	—720.3	—107.1	14.8	13.8	....	—10	....
382	—703.5	— 45.0	11.7	11.2	....	— 5	....
387	—687.6	—252.2	10.4	10.2	....	— 2	....
399	—644.9	+ 15.4	12.5	12.5	....	0	....
402	—635.1	—314.2	12.3	11.3	....	—10	....
409	—608.9	—539.2	13.9	13.0	....	— 9	....
413	—593.4	—776.6	15.0	14.8	....	— 2	....
419	—574.7	—701.7	14.2	*d*	....	....	....
423	—558.3	+790.8	10.8	*a*	....	....	....
427	—546.6	— 71.1	10.7	10.9	11.6	+ 2	+ 9
430	—542.2	—206.8	11.7	11.5	11.8	— 2	+ 1
435	—530.1	+ 30.9	13.1	12.0	....	—11	....
438	—525.9	+963.4	9.4	*a*	....	....	....
443	—519.6	+649.4	13.1	*c*	....	....	....
449	—495.5	+290.3	10.5	10.4	10.8	— 1	+ 3
458	—464.7	—107.8	11.2	11.6	12.0	+ 4	+ 8
464	—442.5	—946.4	14.2	14.8	....	+ 6	....
467	—431.0	—658.6	8.7	8.8	9.4	+ 1	+ 7
471	—420.0	—836.5	14.8	14.8	....	0	....
479	—400.4	+272.3	10.0	10.1	10.5	+ 1	+ 5
490	—380.7	— 49.3	14.2	14.8	....	+ 6	....
497	—356.1	—592.2	9.9	10.3	10.7	+ 4	+ 8
505	—309.6	—424.7	9.6	9.6	9.6	0	0
506	—306.0	+ 5.6	11.3	11.3	11.4	0	+ 1
508	—300.9	+704.3	12.3	14.5	....	+22	....
510	—290.9	—505.9	13.1	13.5	....	+ 4	....
516	—276.0	— 29.5	13.5	13.8	....	+ 3	....
523	—242.3	—116.0	10.1	10.2	10.0	+ 1	— 1
524	—241.4	+ 16.8	12.5	13.4	....	+ 9	....
532	—218.6	+449.6	14.2	*d*	....	....	....
543	—196.1	+909.4	10.3	*a*	....	....	....
545	—195.5	—401.3	13.1	13.8	....	+ 7	....
551	—175.1	+510.8	10.1	11.0	11.4	+ 9	+13
552	—169.2	—393.3	14.9	*d*	....	....	....
554	—163.1	+666.0	9.0	9.4	9.4	+ 4	+ 4
558	—158.9	—118.6	10.7	11.7	11.2	+10	+ 5
563	—120.0	+990.6	14.4	*a*	....	....	....
566	—104.1	—406.3	13.3	13.0	....	— 3	....
567	—102.8	— 8.3	13.9	*b*	....	....	....
570	— 94.8	—273.2	9.4	9.4	9.3	0	— 1

TABLE IV. — *Continued.*

Bond No.	Δα.	Δδ.	Bond Magn.	Common Magn.	Draper Magn.	Resid. Common.	Resid. Draper.
573	—87.3	—179.0	13.9	12.5	....	— 6	....
575	—84.8	— 22.3	11.9	*b*	....	....	....
580	—77.6	+385.8	12.3	14.5	11.9	+22	— 4
581	—76.1	—159.1	14.2	*b*	....	....	....
583	—74.0	—914.	11.5	12.0	....	+ 5	....
587	—61.5	—806.5	13.9	13.2	....	— 7	....
589	—57.2	— 20.4	12 7	*b*	....	....	....
595	—46.9	— 15.0	13.9	*b*	....	....	....
598	—38.6	—455.1	12.3	12.0	12.0	— 3	— 3
599	—36.5	—974.1	11.8	11.2	....	— 6	....
601	—36.	— 31.	15.6	*b*	....	....	....
602	—33.0	— 67.5	14.3	*b*	....	....	....
605	—27.8	—953.3	13.9	13.2	....	— 7	....
608	—23.7	— 18.0	14.3	*b*	....	....	....
612	—16.4	+ 24.6	13.5	*b*	....	....	....
615	—12.0	+500.5	14.2	*d*	....	....	....
617	—10.7	+ 12.9	....	*b*	....	....	....
618	—10.4	+ 24.6	13.1	*b*	....	....	....
619	—10.0	+ 8.7	....	*b*	....	....	....
620	— 9.0	—953.3	13.1	12.5	....	— 6	....
621	— 8.	— 36.	15.6	*b*	....	....	....
622	— 7.5	— 27.8	12.7	*b*	....	....	....
624	— 5.0	+ 16.1	....	*b*	....	....	....
625	— 4.	— 28.	15.6	*b*	....	....	....
628	0.0	0.0	....	*b*	....	....	....
631	+ 3.	— 42.	14.3	*b*	....	....	....
633	+ 3.5	— 2.1	....	*b*	....	....	....
635	+ 8.3	+ 98.3	10.5	10.9	10.7	+ 4	+ 2
636	+ 8.4	— 8 7	13.3	*b*	....	....	....
639	+11.0	—951.5	11.1	10.6	....	— 5	....
640	+11.5	+ 6.8	....	*b*	....	....	....
641	+11.9	+111.2	14.8	*d*	....	....	....
642	+13.	+ 48.	15.6	*b*	....	....	....
647	+22.6	+ 38.0	12.1	*b*	10.3	....	—18
648	+24.2	— 8.7	14.3	*b*	....	....	....
650	+28.5	+408.8	13.1	15.2	12.0	+21	—11
651	+29.4	+ 47.8	13.1	*b*	....	....	....
652	+30.2	+171.6	13.9	13.4	....	— 5	....
653	+30.8	+429.7	13.9	13.5	12.2	— 4	—17
654	+33.2	+ 10.0	12.3	*b*	....	....	....
657	+39.6	+165.2	13.1	12.0	11.6	—11	—15
663	+55.5	+147.1	11.7	14.8	11.2	+31	— 5
666	+59.7	—195.8	13.9	13.8	....	— 1	....
667	+60.5	+848.9	9.4	*a*	....	....	....
669	+63.3	+100.0	9.8	10.4	10.2	+ 6	+ 4
670	+64.2	+673.2	10.8	10.8	10.9	0	+ 1
671	+69.6	— 24.4	11.5	*b*	....	....	....
674	+73.6	+976.5	14.2	*a*	....	....	....
675	+74.5	— 93.4	15.2	*b*	....	....	....
676	+78.5	— 27.6	13.1	*b*	....	....	....
677	+78.6	—201.4	14.8	14.8	....	0	....
678	+79.2	+852.2	13.9	*a*	....	....	....
680	+82.2	—675.3	13.9	11.6	....	—23	....
681	+90.3	+173.2	14.8	13.2	....	—16	....
684	+96.8	+744.8	14.5	*a*	....	....	....

TABLE IV. — *Continued.*

Bond No.	Δα.	Δδ.	Bond Magn.	Common Magn.	Draper Magn.	Resid. Common.	Resid. Draper.
685	+ 97.7	— 95.0	8.3	8.8	....	+ 5	....
686	+100.	— 39.	15.6	*b*	....	....	....
688	+106.	— 18.	15.6	*b*	....	....	....
690	+119.4	—443.7	10.3	10.9	11.2	+ 6	+ 9
693	+131.7	+751.6	13.9	*a*	....	....	....
695	+132.8	+818.1	12.5	*a*	....	....	....
696	+136.2	+886.3	11.5	*a*	....	....	....
700	+143.4	+492.7	11.5	11.0	11.0	— 5	— 5
701	+143.7	—417.2	14.8	13.8	....	—10	....
703	+145.4	+736.4	13.9	15.1	....	+12	....
705	+147.2	+611.2	11.5	11.0	11.2	— 5	— 3
707	+151.2	—253.5	11.2	11.2	11.1	0	— 1
708	+151.4	— 98.5	9.6	9.1	....	— 5	....
709	+152.9	—136.4	12.3	13.4	11.4	+11	— 9
722	+179.7	—710.4	13.3	13.2	....	— 1	....
724	+183.3	—176.0	10.5	10.2	9.8	— 3	— 7
732	+209.7	—570.4	11.5	11.2	11.5	— 3	0
734	+217.7	+443.8	9.0	8.8	....	— 2	....
737	+220.2	+266.1	15.0	15.6	....	+ 6	....
740	+225.5	+841.3	13.1	*a*	....	....	....
741	+225.9	—110.5	10.0	9.6	9.2	— 4	— 8
746	+233.1	—583.8	10.8	10.0	10.0	— 8	— 8
747	+236.4	—333.4	15.0	14.5	....	— 5	....
750	+248.4	—467.1	10.8	11.0	11.3	+ 2	+ 5
755	+277.7	—348.3	14.8	14.5	....	— 3	....
757	+280.5	+666.1	10.0	10.0	10.0	0	0
759	+285.2	+108.7	15.6	14.5	....	—11	....
762	+308.1	—848.7	14.8	15.3	....	+ 5	....
767	+317.0	—193.9	13.9	13.8	....	— 1	....
772	+334.5	+869.2	13.9	*a*	....	....	....
776	+363.	+380.	16.4	15 6	....	— 8	....
778	+366.7	—216.0	13.1	12.1	11.7	—10	—14
779	+370.	+864.	15 6	*a*	....	....	....
781	+373.8	+195.5	10.8	10.6	11.0	— 2	+ 2
783	+386.9	—746.6	13.9	15.1	....	+12	....
784	+388.4	—286.0	10.8	10.6	10.9	— 2	+ 1
785	+389.7	+587.2	10.8	10.6	11.0	— 2	+ 2
786	+389.7	+684.8	13.9	*c*	....	....	....
787	+389.7	+849.3	13.3	*a*	....	....	....
789	+395.9	—245.7	14.8	15.3	....	+ 5	....
793	+414.6	—516.7	11.7	11.5	11.8	— 2	+ 1
794	+416.0	+971.9	12.5	*a*	....	....	....
795	+416.9	—776.5	12.5	12.1	....	— 4	....
797	+427.4	+172.7	15.0	*d*	....	....	....
801	+445.	—282.	13.1	*d*	....	....	....
805	+457.2	+331.9	13.9	*d*	....	....	....
806	+459.8	+780.1	11.7	*a*	....	....	....
808	+464.7	+391.2	11.9	11.8	....	— 1	....
820	+510.8	+978.9	14.2	*a*	....	....	....
822	+514.8	—306.0	10.7	10.0	10.6	— 7	— 1
824	+518.0	+922.2	12.1	*a*	....	....	....
825	+518.1	—716.6	14.2	15.1	....	+ 9	....
826	+521.0	+419.6	14.8	*c*	....	....	....
832	+537.3	—322.4	13.9	14.1	....	+ 2	....
840	+563.	—171.	15.6	*d*	....	....	....

TABLE IV. — *Continued.*

Bond No.	$\Delta\alpha$.	$\Delta\delta$.	Bond Magn.	Common Magn.	Draper Magn.	Resid. Common.	Resid. Draper.
843	+578.1	—853.6	8.6	8.3	....	— 3	....
846	+603.3	—119.1	15.0	*d*	....	....	....
847	+619.4	+634.9	13.1	*d*	....	....	....
848	+631.2	+ 60.2	9.9	9.6	9.6	— 3	— 3
855	+654.0	—989.3	11.0	10.7	....	— 3	....
859	+661.1	—577.5	14.8	*d*	....	....	....
863	+680.9	+357.8	12.5	15.1	....	+26	....
865	+683.1	+957.0	13.9	*a*	....	....	....
873	+707.0	+981.7	11.9	*a*	....	....	....
875	+709.4	+839.4	14.8	*a*	....	....	....
889	+801 6	—258.2	11.3	11.5	....	+ 2	....
893	+815.0	+228.3	13.1	15.1	....	+20	....
899	+861.3	+744.6	14.2	*a*	....	....	....
904	+884.1	—134.0	14.2	*d*	....	....	....
905	+892.8	—918.3	7.8	8.0	....	+ 2	....
908	+901.2	+714.9	13.2	*a*	....	....	....

The light of the brightest stars is derived from Table V., as will be described below. The letter *a* is substituted for the magnitude in the case of stars outside the limits of the photograph; *b* is used to designate stars in the central nebulosity, which are therefore not easily distinguished; *c* indicates stars visible on G, but not on F; and *d*, those not contained on either F or G. The sixth column gives the magnitude derived from the photograph of Dr. Draper. The light of each star in a copy of E was found by Argelander's method, and also by arranging the stars in a sequence. The mean of these magnitudes is that here employed. The last two columns give the residual, expressed in tenths of a magnitude, found by subtracting the Bond magnitude from the photographic magnitudes given in the two previous columns.

A list of the stars visible in other copies of E is given by Professor Holden in Table A, on page 228 of his Memoir. Three of these stars, Nos. 685, 708, and 734, are too bright for satisfactory measurement in E, and two others, 435 and 863, are not visible either in E, D, or C. No. 497 is apparently omitted by mistake in Professor Holden's list. For five stars, 580, 650, 653, 663, and 709, the results derived from E and F are discordant. The first three of these are the faintest stars measured on E, and the last two are so surrounded by nebulosity that the measure is difficult. Were the first three stars as faint as F would indicate, it would be impossible to see them on E. They are certainly visible on D, and 653 on C also. No. 663 is brighter than 681 in E, as bright in D, and not seen in C; in F and G it is much fainter than 681.

TABLE V.

Bond No.	Bond Magn.	A.	B.	E.	E′.	F.	F′.
905	7.8	....	....	....	....	8.0	....
843	8.6	....	....	....	....	8.3	....
467	8.7	....	....	9.4	9.3	8.8	....
685	8.3	8.7	8.8	....	....	8.8	....
734	9.0	....	9.2	....	....	8.8	....
708	9.6	9.0	9.0	....	....	9.1	....
570	9.4	9.4	9.5	9.4	9.2	9.4	9.4
554	9.0	....	....	9.3	9.6	9.4	....
741	10.0	9.3	9.4	9.2	....	9.7	9.5
848	9.9	....	9.7	9.7	9.6	9.7	9.6
505	9.6	....	9.7	9.6	9.6	9.7	9.5
757	10.0	....	....	10.0	10.1	10.2	9.7
724	10.5	9.7	9.7	9.8	9.8	10.5	9.8
746	10.8	....	....	10.0	9.9	....	10.0
523	10.1	10.0	10.3	10.0	10.0	10.5	9.8
669	9.4	9.9	10.0	10.1	10.3	....	10.4
635	10 5	10.1	10.6	....	10.7	....	10.9

The brightest stars in the nebula are compared in Table V. The first and second columns give the Bond number and magnitude. The columns headed A, B, E, and F give the magnitudes derived from those photographs respectively by the method of sequences. The results derived from E and F by the method of Argelander are given in the columns headed E′ and F′. The mean values of E and E′, and of F and F′, are given in Table IV.

One of the most important applications of the determination of photographic magnitudes is to the measurement of the colors of the stars. The rays affecting the photographic plate have in general a less wave-length than those to which the eye is most sensitive. It therefore follows that a reddish star, that is, one in which the rays of great wave-length predominate, will appear relatively too faint in the photograph. The residuals in the last columns of Table IV. will then be positive. A bluish star is similarly indicated by a large negative residual. These residuals form a convenient measure of the color of the stars. In most stars the difference in color is due to slight differences in the relative intensities of the blue and red rays. Until the law defining the relation of the intensity to the wave-length is known, a single number serves to describe the principal cause of the color. Of course in the case of stars in which a large part of the light is concentrated in bands or lines, the residuals will not be directly comparable with those of other stars. Even here, however, this test may be advantageously employed to compare stars of the same class, as, for instance, those of the third type of Secchi.

TABLE VI.

Red Stars.						Blue Stars.					
Bond No.	Bond Magn.	A.	B.	B—A.	Resid.	Bond No.	Bond Magn.	A.	B.	B—A.	Resid.
508	12.3	14.5	15.1	+.6	+2.5	378	14.8	13.8	13.8	0	—1.0
558	10.7	11.7	11.5	—.2	+0.9	402	12.3	11.3	11.4	+.1	—0.9
580	12.3	14.5	14.3	—.2	+2.1	435	13.1	12.0	12.0	0	—1.1
650	13.1	15.2	15.1	—.1	+2.1	573	13.9	12.5	12.3	—.2	—1.5
663	11.7	14.8	14.8	0	+3.1	657	13.1	12.0	12.1	+.1	—1.1
703	13.9	15.1	15.1	0	+1.2	680	13.9	11.6	12.0	+.4	—2.1
709	12.3	13.4	13.4	0	+1.1	681	14.8	13.2	13.2	0	—1.6
783	13.9	15.1	15.1	0	+1.2	701	14.8	13.8	13.5	—.3	—1.2
863	12.5	15.1	15.1	0	+2.6	759	15.6	14.5	14.8	+.3	—1.0
893	13.1	15.1	15.1	0	+2.0	778	13.1	12.1	11.9	—.2	—1.1

The first part of Table VI. contains the stars in which the residual equals or exceeds one magnitude. The first three columns give the Bond number and magnitude and the photographic magnitude, taken from the first, fourth, and fifth columns of Table IV. The photographic magnitude was determined a second time to see if the large residual was due to error. The results are given in the fourth column of Table VI. The difference in the two measures is given in the next column, and in the last column the residual found by subtracting the second column from the mean of the third and fourth columns. The second part of Table VI. gives the corresponding values for the blue stars in which the residual has a negative value exceeding one magnitude.

The first part of Table VII. contains the stars given in the Bond Catalogue not contained in the photograph, and accordingly marked *d* in Table IV. As the faintest stars visible in the photograph have a photographic magnitude of about 15.0, it follows that a slight redness of the stars in Table VII. would account for their absence in the photograph. The stars marked *c* in Table IV. are Bond 367, 443, 786, and 826; although not visible in F, they were detected in G.

The second part of Table VII. contains the stars which are visible in both the photographs F and G, but are not given in the Bond Catalogue. The successive columns give a current number, the approximate difference in right ascension and declination from θ^1 *Orionis*, and the photographic magnitude.

Many more objects which cannot be distinguished from stars are visible on either F or G, but not on both. After completing this list, it was compared with the map of the Earl of Rosse (Phil. Trans., 1868, Pl. III.). Stars appear on this map which are moderately near Nos. 4 and 11, but none are near any of the other stars in the second part

TABLE VII.

Bond No.	Bond Magn.	No.	$\Delta\alpha$.	$\Delta\delta$.	Magn.
329	14.2	1	—464	— 424	14.8
332	14.8	2	—370	— 122	13.8
419	14.2	3	—143	— 611	13.5
532	14.2	4	—120	— 515	13.5
552	14.9	5	— 62	— 514	13.8
615	14.2	6	— 17	—1011	14.5
641	14.8	7	— 9	— 592	13.8
797	15.0	8	+ 34	— 960	14.8
805	13.9	9	+ 42	— 854	15.1
840	15.6	10	+ 77	— 480	12.7
847	13.1	11	+316	— 639	13.0
904	14.2				

of Table VII. None of them are given in the list prepared by Lord Rosse of the stars not contained in the catalogue of Struve (Phil. Trans., 1868, p. 59). A comparison with the map of Mr. Common (Monthly Notices, XLIII. 256) showed that Nos. 10 and 11 were already given there. Mr. Common's stars *nf.* 690 and *np.* 750 are not visible on G, although the first of them is well shown on F. The stars near Bond 685 and 741 were not measured on account of the nebulous light with which they are surrounded. Their presence in G is somewhat doubtful. Until the remaining stars are actually seen, we may infer that they are too faint to be visible to the eye, and that our only evidence of their existence is by means of the photographic plate. These stars are also probably of a bluish color. As the number of stars is nearly the same in the two parts of Table VI., we may infer that for white stars the limiting magnitude for the photograph does not differ much from that for the eye.

The agreement of the results given on page 408 is hardly a fair test of the errors of measurement. A better indication is afforded by the repetition of the measurement of the red and blue stars in Table V. The average difference in the results is .14 of a magnitude, which indicates a probable error of each of about .08. The two measures of E by Argelander's method and by sequences give for the 35 stars compared by both methods an average deviation of .20, or a probable error of .12. Forty stars are common to E and F. Omitting the five which are stated on page 413 to be discordant, the average difference in the two magnitudes of the remaining thirty-five is .27. The probable error of each, if they are equal, is .16.